

CHAPTER VII.

**Ailments and Diseases of the Goldfish
and Other Freshwater Fishes**

AILMENTS AND DISEASES OF THE GOLDFISH AND OTHER FRESHWATER FISHES, AND THEIR REMEDIES

As already stated, the appearance and conduct of the goldfish and other fishes are the surest indications of health or illness. A bright color, clean appearance, expanded fins, lively disposition, good appetite and active digestion are indicative of good health; while a dull color, coated or inflamed body and fins, a congested appearance, drooping or fraying fins and tail, apathy, loss of appetite, and disturbances of the digestive system indicated by the unusual appearance of the excrement, are equally certain indications of illness.

The goldfish is not only subject to the usual ailments of fishes but to others incidental to the unnatural conditions under which it is propagated, marketed and kept in captivity. Many of the diseases are the result of unsanitary conditions due to inexperience, neglect or overkindness; others are due to infection and the presence of external and internal parasites. These diseases may affect the surface and the fins, the respiratory organs, the digestive, pulmonary and muscular systems, and the swimming bladder. This important subject will be treated of at large, as investigations of the diseases of goldfishes and their remedies have not had the careful attention which has been devoted to other domesticated animals, and on account of the meagre data it is difficult to classify them other than on general lines.

At all stages of their existence fishes are subject to a variety of diseases. The spawn is attacked by a white fungoid growth which covers the exterior with a mat of fine hair like filaments, first visible on unfertile eggs but which spreads to others with which it comes in contact. A similar fungus attacks the umbilical sac of the alevin. Numerous other diseases also afflict the fry, while the organic and parasitic diseases of goldfishes may be classed as systemic, surface, gill, fin, fungus and parasite, the origin of which may be traced either to simple or to more complex and obscure causes; all more or less fatal to these beautiful household pets of which fine specimens are probably more difficult to rear than any other domesticated animal.

DETECTION OF ILLNESS. In good health, the goldfish swims with a slow and regular motion, with the dorsal fin erect and the pectorals moving easily and regularly. When startled it darts to the bottom by a vigorous stroke of all the fins. When ill or out of condition, the movements are languid or the fish will remain motionless near the top or on the bottom of the aquarium, the dorsal fin folded on the back and the movement of the pectorals listless, as though the fish were unwilling to make exertion.

When startled it will slowly sink to the bottom, soon to return to its former position, or when on the bottom will seek to secrete itself.

This appearance is sometimes due to improper water conditions, which may be easily remedied. But when the body becomes coated and the fins pointed, then frayed, ragged, congested or inflamed, as these are certain indications of advanced illness, it behooves the fancier to investigate the cause or to consult an experienced breeder. Let it be stated, however, that it is not well to accept of promiscuous advice.

TREATMENT OF DISEASES. In treating the diseases of goldfishes the natural self-remedies of freshwater fishes should be applied under similar conditions as far as practicable. In a state of nature the fishes seek brackish or salt water, saline deposits or salty earths for some of their illnesses; or darkness, light, deep or shallow water, abstinence from food, natural purgatives and rest for others. These conditions should be imitated by the aquarist when his pets become afflicted with such ailments that in his judgment would be benefited by their application. In addition the remedies hereafter mentioned should be tried.

SANITARIUM AND HOSPITAL. Where many fishes are kept, it is advisable to have an aquarium or battery jar in reserve in which a luxuriant plant growth has been developed, to serve as a sanitarium in which fishes of doubtful appearance may be isolated and quarantined, to prevent the spread of diseases, and which would also serve as a "snail farm" as young snails are one of the best articles of diet for sick fishes. In such sanitarium the plants should be grown in pots or dishes that they may be removed without disturbance when it is necessary to thoroughly clean both the jar and the plants. It may be well to here mention that a $\frac{1}{20000}$ solution of bichloride of mercury can be used for cleaning purposes, but plants and receptacle must afterwards be thoroughly washed with clean water.

As a hospital a well seasoned tank, if possible one having an active growth of algæ on its sides, is best. It should contain considerable well developed plant life and the water should have a bright green color, indicating an active growth of the smaller algæ. The plants should be rooted in clean soil in pots with a slight covering of grit, because earth and mud are beneficial to sick fishes. The tank should have a large surface area as compared with its depth; the latter not to exceed 12 inches. In the summer, it should be partially protected from the sun, but in winter it should get the full sunlight, and should be kept at a temperature of 60° to 70° F. One end may be covered with a board when fishes are introduced, for rest and shade.

All vessels for fishes having contagious and parasitic diseases should be of glass, so that they may be thoroughly cleansed. A sick fish does

not require a large receptacle, but it should be of large diameter in proportion to its depth, or else the depth of water so regulated. The sides should be screened or curtained when necessary to permit of rest for the patient.

Breeders, dealers and others having a large number of fishes, should have a hospital for fishes "out of condition"; but which is not used for those in the active stages of contagious and parasitic diseases though it may be used later for such patients when the danger of contagion has passed and they are convalescing. From this receptacle they may later be transferred to the sanitarium and only returned to the aquarium when fully recovered.

At all times when a fish gives indications of being out of condition, it is best to remove it from its companions for the following reasons; first, it prevents the well and stronger fishes from annoying it, second, while the illness may be only slight, it may also be a contagious affection; third, it gives opportunity for the required treatment or for experimentation with the view of a cure, which could not otherwise be undertaken. A sick fish should have nourishing food offered to it, for if it will eat the chances of recovery are greatly increased.

REMEDIES. Beneficial remedies for the ills of fishes are but few, and the medicaments of the aquarist should consist of the following:

- Common table salt and rock salt, frequently required.
- Phenol-sodique, frequently required.
- Peroxide of hydrogen, frequently required.
- Epsom and Glauber salts, as laxatives, frequently required.
- Castor oil, as a cathartic, occasionally required.
- Boracic acid solution.
- Saturated solution of Monsell's salt.
- Permanganate of potassium solution.
- Gypsum and plaster of paris.
- Coal Oil.
- Tincture of aloes and myrrh.
- Turlington's Balsam.
- Antigyrodactylin.
- Bichloride of mercury, as an antiseptic and parasiticide.
- Salicylate of soda, " " " " "
- Chlorate of potassium, " " " " "
- Formalin, " " " " "

NOTE: A few drops of Monsell's salt, less than 10 to the gallon, will clear turbid water, due to the decomposition of chlorophyll, and 15 to 20 drops to the gallon will destroy many of the lower organisms. It is also fatal to the snails, which should be removed before it is used. A few drops of a weak solution of permanganate of potassium in the aquarium will remove the green color, when objectionable.

FUNGUS ON SPAWN. The spawn of fishes is attacked by a fungus which manifests itself by short hairlike growths on the surface. Fig. 75. It



Fig. 75. Fungus on Spawn.
Saprolegnia ferax.
Greatly enlarged.

is usually one of the species of the Saprolegniaceæ, *Saprolegnia ferax* or *Dictyuchus polysporus*, the spores of which are present in all natural waters, and are more fully described hereafter.

TREATMENT. There is little to be done for this diseased condition other than to pick out the affected eggs with tweezers. Even then more fertile eggs may be injured than would be saved. Under good conditions only the unfertile opaque eggs are attacked; and if the parents are healthy and the water conditions good, these are not likely to be present in sufficient number to warrant the removal of the affected spawn. If the fishes are weak or over-

spawned, at times nearly all the eggs are unfertile or the fry hatches weak, and on such occasions all the eggs and fry may be attacked by the fungus. When in a day or two the spawn shows a majority of affected eggs, it is best to destroy both it and the spawning plants, to prevent a further spread of the fungus and the diseased condition.

It is probably always best to take the spawn and the plants to which it adheres from the spawning bed and place them in filtered water to hatch, thus largely avoiding the danger of the presence of fungus spores and those of parasites; but a few pots of growing plants should be introduced to supply the necessary oxygen and to prevent the asphyxiation of the fry. A small dish containing clean soil should also be furnished as it contains substances necessary for nutrition and will stimulate the development of minute plant and animal life, the first food of the young fry. The presence of these low forms is manifested by the greenish color of the water. After the fry are a week old, a half pint of water of pronouncedly green color should be added every few days, and then live food should be fed.

WHITE FUNGUS. One of the most frequent diseases of the goldfish and other aquarium fishes is manifested by the appearance of a white coating on the tail and fins which spreads to the body, operculæ and into the gills of the fish, destroying the fins, covering the body with a threadlike scum and finally causing the death of the fish from exhaustion, asphyxiation and interference with the proper functions of the skin by obstruction of the surface pores and the induced inflammation. Figure 76.

The disease is most often introduced into the aquarium by newly acquired fishes that may have been shipped long distances in cans containing

such numbers that the water is not sufficiently aerated, or which have been bruised and otherwise injured, enfeebled from lack of food, or have suffered from constant excitement. Carelessness of their comfort, lack of



FIG. 76.—Head of a Goldfish affected with the so-called White Fungus. Usually *Saprolegnia* and *Dictyosphaeria*.

proper care while in the hands of dealers, unsanitary conditions, insufficient plant life, decay of the plants and food, overstocking and similar causes, will also produce the disease; as under these conditions the ever-present micro-organisms attack the weaker fishes and spread to healthy ones with which they come into contact. Another cause is sudden changes of the temperature of the water by injudiciously adding thereto, or its continued low temperature. This is a most frequent reason for outbreaks of the disease in the spring, as the above conditions often prevail during the winter and the vitality of the fishes has become low, so that they succumb to this fungus when it becomes more

active owing to the rise in temperature. A very large proportion of the mortality among aquarium fishes is due to this cause.

This White Fungus is one of the most common diseases which the amateur is likely to encounter. When neglected, it is serious in its effects and results, but if taken in time, proper care exercised and remedies applied, death losses will be reduced or prevented. Owing to the general natural or surgical contingent, in advanced stages, destruction of fin and tail development and much loss of beauty may occur, with a probability that the fish will never entirely recover its former beauty.

TREATMENT. When a fish shows fungoid tendency it should be removed from its fellows and placed in a hospital jar, containing 2½ gallons of water, to which a teaspoonful of table salt, the same quantity of epsom salt and 10 or 12 drops of Phenol-sodique have been added. The jar should also contain a partially opened inverted earthen flower pot, or similar vessel, in which the fish may hide and rest. It should be kept out of the sun, at a temperature of about 65° to 70° F. During two days the fish should not be fed, as the disorder may be the result of overfeeding; but, if at the end of this period there is no improvement, it should be taken out and all the fungus spots painted with coal oil, the fish being then placed for a short period in another receptacle to allow the excess of oil to float off, when it may be returned to the jar. Penciling with or dipping into a 50 per cent. solution of peroxide of hydrogen is also an approved remedy.

If the fungus has extended and the fins and tail become ragged, it is necessary to cut off the affected parts, painting the cut edges with Phenol-sodique, tincture of aloes and myrrh or with the peroxide of hydrogen solution. If the spots are extensive on the body they should be cleansed with a table salt or peroxide solution and also painted with the tincture of aloes and myrrh. Immediate attention is necessary as soon as the disease is detected, then a cure is almost always possible.

If the fish improves, the white appearance disappears and a dark edge shows on the fins and tail. It may then be transferred to the hospital tank to acquire strength on a light mixed diet, sparingly but frequently fed, but if it becomes weaker, the fungus extending over the sides and into the gills, unless it is very valuable, it is best to destroy it, because little more can be done for its benefit. A final recourse is to place it in the greenest water procurable and leave it there. Sometimes it recovers, but it may be subject to a recurrence of the disease, or may present only a wreck of its former appearance and beauty.

A recently introduced and approved remedy is the Turlington's Balsam. It is applied as follows:—The affected parts should be dried and cleaned and the balsam applied generously with a small brush or a pledget of cotton and permitted to dry from three to five minutes. During this time the head and gills of the fish should be wrapped in a wet cloth to keep the gills moist and to prevent movement. If this is properly done no fear of endangering the life of the fish need be entertained. The Balsam coats the affected edges with an insoluble surface and protects them from the further ravages of the fungus. Also apply the parasiticides mentioned hereafter. Prompt measures have saved many valuable aquarium fishes.



FIG. 77. Head of a Goldfish affected with the so-called Black Fungus. Usually *Gyrodactylus* and *Myxidium*.

BLACK FUNGUS. This serious evil attacks the goldfish in a similar manner to the White Fungus, but is only conveyed by contagion and does not so much depend upon the water and other conditions. It is manifested on the body and fins. These first assume a mottled dark grey appearance in spots and streaks; later they become black and form a thick layer which scales off, leaving raw spots and ulcers on the body and destroy the fins and tail. The indirect causes are the same as those which induce the White

Fungus, but the direct causes are animal parasites usually *Gyrodactylidae* or *Myxidae*, Figs. 77 and 78, of the order Protozoa, the most general of the fish parasites, and others, all more fully described hereafter.

TREATMENT. If these parasites get into the gills, the best and only thing to do is to destroy the fish, to prevent further infection, thoroughly clean the aquarium or tank with antiseptics and burn the plants and the fish.

If, however, only the fins and part of the body are affected, it is well, if the fish is of value, to attempt a cure. These being animal parasites and usually deeply seated in the tissues, severe treatment is required, which is often as nearly fatal as the disease itself. The parasiticides should be first tried, which sometimes effect a cure, but if not of benefit, the fins and tail should be cut off some distance beyond the affected parts, the spots on the body scraped, all the affected parts painted with a solution of Monsell's salts, and the fish



FIG. 78. Trematod parasites taken from imported Japanese and Chinese Goldfishes affected with Black Fungus. Greatly enlarged.

kept in a jar containing salt water to which 10 or 12 drops of Phenol-sodique per gallon have been added, and the affected parts also penciled with a 50 per cent. solution of peroxide of hydrogen. If the fish survives a day or two, then the affected parts should be daily painted with coal oil after cleaning with salt water, or with peroxide of hydrogen, always placing the fish into a receptacle for a few minutes before returning it to the jar. Turlington's Balsam will be greatly beneficial should the fish survive to the healing stage. Nourishing food of animal origin should be generously fed, such as the yolk of a boiled egg, ant larvæ, earthworms, etc. Everything with which the fish has come in contact should be cleaned and sterilized and its companions quarantined in water containing salt to the amount of imparting a brackish taste. Upon the microscope slide the parasites which produce the disease are killed by salt, but this remedy does not always reach and destroy them when they have burrowed into the tissues, under the scales and skin, and in the gills of the fish. The same trials of remedies as for White Fungus should also be made. Also apply the parasiticides hereafter mentioned. Cures are frequent if prompt attention is given. Severe attacks seldom occur in well-established aquaria.

TWITTERS OR ITCH. This quite common affection of the goldfish is produced by minute Infusoria, *Ichthyophthirius* and *Chromatophagus*, the leech-like *Trichodina*, and other fish parasites, which develop under unsanitary conditions or are principally troublesome in the presence of decomposing food and decaying vegetation. They are frequently introduced into established aquaria by newly received fishes, on plants or with the water.

The affected fishes become restless, endeavoring to alleviate the irritation and dislodge the parasites by rubbing against objects in the water or on the bottom. A close observation in severe cases will reveal the presence of cysts in the skin of the fish or a white scum on its surface, and sometimes a congested appearance, due to the presence of parasites.

TREATMENT. Cure is usually effected by immersion in a strong salt solution until the fish shows signs of exhaustion, or by rubbing it gently with a saturated salt solution on a pledget of cotton, followed by similar treatment with slightly diluted Phenol-sodique; or a weak solution of permanganate of potassium diluted until it is of the color of claret; but a better method is to place the fish in a weak salt solution for several days, as this is less likely to injure the mucus covering of the surface and the parasites yield as well to this mild brackish water treatment. Change of water, more scavengers, especially tadpoles, which often eat the parasites off the sides of the fishes, greater care in feeding, siphoning out the humus in the aquarium and other simple sanitary regulations will obviate this evil.

AUTOXINE. Fright, constant fatigue, lack of rest, too strong light and other abnormal conditions often produce in the aquarium fish a jaded and exhausted condition, loss of vitality, surface irritation and interference with the respiratory and digestive systems which render it liable to diseases to which it would be immune under normal conditions. One of these is known to the breeder as Autotoxine or self-poisoning. It affects the scales and gills and causes the formation of a scum or slime, similar in appearance to White fungus, which weakens the fish, disturbs its normal functions and causes a partial suffocation under which it soon succumbs.

This is a complaint of mature fishes, but also frequently affects younger ones during the winter months. When the latter is the case it is advisable to add rock salt to the water in which the fishes are kept at intervals of twice or thrice a week, but never to the extent of imparting a salty taste, because such excess would be injurious not only to the fishes but also to the plants, interfering with their functions as liberators of oxygen.

TREATMENT. Mature fishes so affected should be rested in a screened aquarium or placed in a jar containing a teaspoonful of epsom salt to the gallon and kept in a darkened place for several days without food. Later the food should be frequently changed to give a variety, feeding lightly and adding a tablespoonful of salt to each 5 gallons of water in the container. Usually more plant life is also required, more especially those which are the best oxygenators; the main remedy being healthful surroundings, complete rest, exclusion of excessive light, and careful feeding.

CONSTIPATION. In the aquarium or tank goldfishes often suffer from the confinement, lack of proper exercise, restlessness, the results of their

unnatural surroundings and the too concentrated forms of food, which bring about disorders of the digestive organs causing constipation. This may be detected by the appearance of the excrement, which in good health and with natural food is of a uniform brown or black color. In confinement the excrement is largely influenced by the nature of the food; but it should be of uniform color and usually pendant for quite a considerable length. When its appearance is other than usual the fish may be either overfed or constipated. The latter is usually the case when the excrement is of varying color, white, brown and black in sections or otherwise abnormal. In overfeeding the excrement is always white.

TREATMENT. A laxative is occasionally necessary, for which purpose table salt, epsom and glauber salts and earthworms are to be recommended. Many of the prepared foods contain these salts, but a little added to the water from time to time is beneficial; the fishes take it greedily, as they have the same craving for saline substances as other animals. Epsom salt is a mild laxative and will prevent constipation and the concomitant evils produced thereby. A fair-sized pinch should be dropped into the water every week or fortnight, alternating with table or rock salt, to insure a proper and healthy digestion. Aquarium water is also often deficient in mineral salts from absorption by the plant life and the salts so added are beneficial correctives. If a fish is excessively constipated, as may happen, a drop of castor oil placed well down the throat is generally effective, and at all times is harmless to the fish. A second dose may have to be given. Fresh earthworms are also an efficient laxative for aquarium fishes. What may appear to be inflammation of the swimming bladder may only be constipation, for which reason it is always well to apply these remedies in doubtful cases.

FIN CONGESTION. The fins of goldfishes, especially the tail, often become red and congested, which is manifested by inflamed and bloody streaks, lines or spots which cannot be mistaken for the arteries and capillaries. This may be produced by constant excitement, impure water, insufficient aeration, overfeeding, partial suffocation, bladder trouble, the dragging of the tail over the bottom, or from other not readily recognized causes.

TREATMENT. A successful remedy is to place the fish in water in which sufficient table salt has been dissolved to give to it a brackish taste, feeding sparingly or not at all for a few days, together with isolation in a subdued light and complete rest. Some fanciers treat the fish by frequently dipping the affected parts in a strong salt solution, though this should be done with discretion as it may have the effect of further irritating the already congested membranes. The author does not recommend these harsher methods and gives them only because they are often resorted to. Laxa-

tives, however, are always beneficial and should be given in repeated small doses, a cathartic of castor oil being preferable. Frequently dipping the body and fins into dilute peroxide of hydrogen has proven to be an effective remedy. Better aeration alone may effect a cure.

TAILROT. This affection, which seems to be a sequel of a generally congested condition, usually starts at the ends of the tail and fins. These first assume a serrated and then a shredded appearance, the disease causing

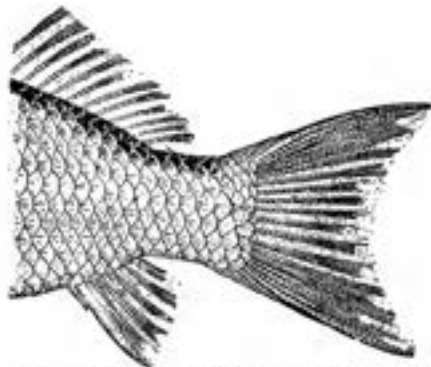


FIG. 79. Fins of a Goldfish affected with Tail-rot; early stage.

a decay and separation of the connective tissue and the rays, so that they assume a bristlelike appearance. Fig. 79. When it reaches the base of the tail and the spinal column it is usually fatal; but prompt treatment will in most cases arrest the ravages of the disease and effect a cure.

TREATMENT. The treatment for White fungus and Fin congestion should be first tried, and if found to be ineffective, the affected tail and fins should be cut off beyond the diseased parts and the fish subjected to a salt bath to prevent a further spread. A laxative of epsom salt and a drop of castor oil as a cathartic are usually called for; and treatment by dipping the affected parts into a solution of a tablespoonful of Phenol-sodique in a gill of water, or a 50 per cent. solution of peroxide of hydrogen; or into water in which bichloride of mercury has been dissolved in the proportion of one tablet to the pint, have been recommended and tried with success, but great care must be taken in using this latter remedy that it does not get on the gills. Good results have also been produced by applications of Turlington's Balsam as before suggested for Fungus, and of the Tincture of aloes and myrrh. Caustic mineral acids, especially nitric acid have been used by experts with success. To cauterize the affected parts; applications should be made with a skewer of soft wood dipped into the acid. This remedy should be resorted to only when the others have failed to effect a cure.

GILL CONGESTION. This disease, also known as Asphyxia and "Sore throat," occurs with fishes which have been subjected to sudden changes of temperature of the water or to other exposures that may cause inflammation or congestion of the gills, such as removal from the house aquarium to an out-of-door existence, undue exposure, improper water conditions or similar causes that disarrange the respiratory organs, affect the functions of the gills and debilitate the fish. Loss of appetite, emaciation and

enervation will result and then immediate remedies are necessary or the fish will succumb.

A congestion spreads over the gill membranes and into the throat, which become highly inflamed and assume a grey or whitish appearance; they no longer perform their proper functions and finally become mortified. Animal parasites also find lodgment in the diseased gills and unless treatment is at once undertaken the fish dies of exhaustion.

This condition rarely occurs with strong fishes, but is quite common with highly bred Chinese and Japanese goldfishes which have large fin and tail development and extreme delicacy of constitution. At times a condition somewhat like Consumption in the human race produces similar symptoms to the above and can only be differentiated by careful examination of the gills; but as the same treatment applies to both, the distinction is not pertinent.

TREATMENT. Rest under the most favorable conditions, stimulation by nourishing food and treatment of the gills are advisable. The fish should be placed in a receptacle having abundant plant life, shielded from strong light and an equable temperature maintained. If the disease is advanced, the gills should be treated with an injection of salt water at repeated intervals and the fish placed in shallow water in a large dish so that the action of the fins keeps it in agitation and causes the absorption of as much air as possible, or the water should have frequent aeration with a fountain syringe. The relief from the water pressure, thus afforded, is also beneficial. Placing the fish in a receptacle under constantly dripping water has preserved the life of many fine specimens that otherwise would have succumbed to diseases. Care must be taken that the water is of the same temperature as that of the aquarium, and is best at about 60° F.

When gill parasites have made considerable ravages no remedy or means for their eradication have as yet been found, and the death of the fish is certain, but the usual gill and throat congestion can be cured by immediate attention.

Young fishes are particularly liable to gill and throat parasites, the most usual of which are *Gyrodactylus* and *Echinorhyncus*. These may occur epidemically, often at intervals of several years, and have at times destroyed nearly all the fishes of an entire season's hatchings. They sometimes infest the gills in such numbers as to cause the operculæ to stand from the sides of the head, induce inflammation of the gills and ultimately cause the suffocation of the fry. For this condition there is no remedy and thorough cleaning, destruction of fry, plants, etc., by burning is necessary to prevent further infection.

CONSUMPTION. What is generally known as Consumption in the gold-

fish may be due to widely different causes. It consists of a gradual emaciation whereby the entire appearance of the fish is changed. The body becomes shrunken and lean, most noticeable at the junction of the head and the spinal column. The sides are depressed, particularly along the back, and the abdomen is shrunken. The operculæ are sometimes protruding, giving to the head an abnormally large appearance, and at other times the edges are depressed, as though folded in on the gills. The fish has a general appearance of feebleness, lethargy and listlessness, frequently accompanied by an abstinence from food.

TREATMENT. For this illness there is no certain remedy, though its progress may often be arrested by removal to a separate aquarium or to tanks out-of-doors under the most favorable conditions, together with trials of a stimulating diet of animal substances, earthworms, raw beef, ant eggs and fish-roe, the later prepared by first parboiling in salt water and then drying in a moderate heat. Great care must be exercised in feeding these animal foods that all is immediately consumed or later removed. It should be noted that extreme care may keep the fish alive and in fair condition, if it will eat, yet the slightest change or exposure will rapidly cause fatal results. When the condition is permanent, such fishes should not be used as breeders, not only because the majority of the spawn is usually unfertile but also for the reason that the hatchings produced are feeble, few of the fry reaching maturity and these generally with a similar tendency. Therefore, unless the fish is valuable it is not worth the trouble of keeping it in condition and it would better be destroyed.

EYE INFLAMMATION. The protruding eyes of the Telescope goldfishes especially those of the males during the breeding season, are frequently injured and serious inflammations may occur. When so affected the eye seems to protrude farther from the orbit and the cornea becomes opaque or of a milky color. This condition sometimes goes no farther and the eye gradually becomes normal in a month or more; but the inflammation may continue to such an extent that ulcers form and either entirely destroy the cornea or leave a blinded fish. If both eyes are affected, the fish is temporarily blinded and may suffer through inability to find food.

TREATMENT. However treated there is always danger of permanent injury, but probably the best results are obtained by washing the eye with a pledget of cotton dipped in a saturated solution of boracic acid once a day until beneficial results are produced. The fish should be isolated and food placed so that it may find it by touch, and, in extreme cases it may be fed by hand. In severe cases it takes nearly three months for complete recovery, but the above treatment is almost invariably successful in about one month, if the fish is in vigorous condition, and treatment undertaken at once.

SWIMMING BLADDER TROUBLE. The confinement incident to existence in the aquarium, together with water impurities and insufficient aeration cause affections of the swimming bladder of the goldfish; but it is more likely that such diseases are congenital and due to malformations of the bladder, as they occur most frequently in highly bred, very short-bodied fishes. The disease is not always noticeable in its incipiency but develops more and more, becoming evident in the second and third months by irregular action and later by partial or entire lack of control over the movements. For example, the fishes may not be able to rise from the bottom of the aquarium, or may swim only on the surface of the water, often in reversed position; or they may only be able to swim with the tail uppermost, or altogether on their sides.

A fish may have this affliction, be strong, eat well and grow; but it is unsatisfactory in appearance and undesirable to breed from, as many of the progeny may be similarly afflicted. This ailment is most general with the Chinese varieties, and the transparently-scaled white fishes with blue eyes are most usually so affected. Diseases of the liver and spleen produce similar symptoms. Sometimes it is due only to too cold water.

TREATMENT. No cure or method of alleviation is known, though keeping the fish in water at a temperature of 60° F. and over, has been found to be beneficial; because fishes so afflicted become worse or entirely helpless in cold water. Unless the fish is valuable it is best to destroy it, in order to put it out of its apparent misery. Castor oil and other remedies for Constipation, however, should first be tried.

DROPSY. This is not a disease in itself but is a symptom secondary to an affection of the liver or the spleen. It produces a distended appearance of the fish by the presence of serum in its tissues, together with loss of the control of its movements. In advanced cases, there is a ruffled appearance of the scales, and sometimes a protrusion of the eyes and operculæ and finally complete helplessness and death.

TREATMENT. No cure, either in fishes or other animals, is known for this affection of the liver, and its resultant dropsy. If the fish is otherwise strong, has a good appetite and assimilates its food, palliative measures by surgical operation, similar to that used with mankind, (tapping), will often prolong life for years and keep the fish in apparently good condition, although the operation may have to be frequently repeated. When the abdomen is greatly distended, a small trocar, (a hypodermatic needle is excellent for this purpose), inserted on each side from below upward and outward, just under the skin, will open canals through the connective tissue, which will enable the serum to exude, thus reducing the diameter and relieving the condition. It is, of course, imperative that no organ of the body is injured. This operation has been performed five times in

two years upon a mature "blue-ribbon" Japanese Fringetail goldfish which is in good condition at the present writing, but which will soon require another puncture. If the affected fish is immature and not otherwise strong, robust and of very fine appearance, it is not worth the labor and attention and should be destroyed. Remedies for Constipation and Bladder trouble should be tried.

INJURIES. Careless handling, rough nets, bruises, loss of scales and the injurious effects incident to transportation cause injuries to the scales and skin which should have immediate attention, as they form culture surfaces for fungi and lodging places for parasites.

TREATMENT. A thorough cleansing of the injured parts with salt water, followed by diluted phenol-sodique or peroxide of hydrogen should be first applied and then the abraded spots treated with a coating of Turlington's Balsam, to keep the water from coming into contact with the wound. This is almost always an effective remedy.

HANDLING DISEASED FISHES. Fishes may be handled out of the water by keeping the head enveloped in a wet cloth to keep the gills moist. Several minutes out of their element will not be injurious when this method is employed.

The cleanest cut in operations on fins and tail can be made by spreading them on a smooth board and making a straight pressing cut with a knife. Scissors produce uncertain results.

A microscope examination of scrapings from the diseased parts is advisable. It nearly always reveals the cause of illness and prompts in the use of proper remedies.

It is a wise precaution to employ a separate net and all other appliances in the handling of sick fishes, as there is constant danger of spreading the contagion. These should be sterilized by boiling water or with antiseptics.

The best mild disinfectants for aquaria are Monsell's salt solution and permanganate of potassium; while for radical disinfection bichloride of mercury, chlorate of potassium or formalin are most certain of result. Bichloride of mercury is to be used in the proportion of one tablet to the gallon of water and formalin in a 4 to 6 per cent. solution, both in water. Care must be taken to remove all traces of these antiseptics.

LARGER ENEMIES OF THE GOLDFISH. These are limited by the conditions and surroundings in which the fishes are kept; but all predatory animals are active enemies when they can obtain access to the young and mature fishes. These may be the common rat, cat, mink, muskrat, mole, starnosed mole, kingfisher, sandpiper, great horned owl, heron, crane, crayfish, frog, water snake, larger fishes, and all the predaceous aquatic insects. Most of these can be excluded by wire netting covers over the tanks.

CONCLUSION. There can be no question that the finely bred Goldfishes are more liable to illnesses than the ordinary breed. They are all constitutionally weak and naturally subject to disturbances of digestion, ailments of the swimming bladder, dropsical tendencies, and physical exhaustion; the latter due to atrophy of the muscles from disuse and from having gone largely into the formation of the abnormally long and duplicated fins, the very effort to wield which is exhausting and compels the fishes to swim as much by movements of the body as of the long unwieldy fins and tails. When affected by diseases these fishes are devoid of much repellent, recuperative or sustaining power, as they are coddled, weakly, unnatural monstrosities in whom life is kept by the constant attention of the fancier. It will be noticed that it is the most highly prized fishes which are most prone to illness and which soonest succumb, so that the losses to the breeder are principally these and not the "sports" or partial reverts. But on account of their value and the constant demand, the toy varieties receive the principal attention of the skilled breeders, to which must be added the fascinating uncertainty as to the result of a season's labor, as any fish that hatches may possibly develop into a fine specimen, if it survives.

Although the foregoing investigations of fish diseases were conducted by the author and his expert friends with aquarium fishes, the diseases and remedies also apply to food fishes, and the methods of treatment suggested can be used for them as well, if modified to suit existing conditions. The tenacity of life of the common goldfish is such that it is generally employed for ichthiologial research pertaining to diseases and their treatment.

PARASITES AND PARASITIC DISEASES

The diseases of fishes are both parasitic and non-parasitic. Of the former, the parasites may be either animal or vegetal; which, according to the parts infested, are classed as Ecto- or surface and Ento- or internal parasites. It is proposed to briefly describe the common forms and the more or less effectual treatment for their eradication.

ANIMAL PARASITES AND PARASITIC DISEASES. Nearly all classes of animals include among their inferior ranks members which are either parasites or messmates at some period of their existence. True parasites are those which live at the expense of their hosts, either establishing themselves in their organs and tissues or leaving them after a meal, like the leech and the larvæ of predatory insects; while others require this assistance at determinate periods, either in early youth, like the young of some mussels, or during the infirmities of old age, though many are internal or external lodgers all their lives. Messmates are those which share in the

meals of other animals, attaching themselves to, or only accompanying, their more vigorous hosts.

The science of Helminthology has determined that many of the parasites live at various stages of their existence in widely different animals. This particularly applies to those of fishes, which more than others are subject to parasitism, not only in the number which they harbor but also in the frequency with which this occurs. Each genus is subject to a number peculiar to itself as well as some common to all. These inhabit various parts of the body, the skin, connective tissues and muscles; the heart, liver, respiratory and digestive organs, either free or encysted. The most of them, however, exist in the intestines and alimentary canal or in the gills and on the surface. They are sometimes harmless but more often injurious, as their progeny may be so numerous as to tunnel in all directions until the whole organ or part of the tissue which they inhabit is little more than a sac of microscopic worms.

Fishes acquire internal parasites with their food, while those which affect them externally, are usually free-swimming at some stages of their existence. These belong to different groups of the lower animals, of which some of the common North American forms will be enumerated, for the further identification of which the reader is referred to the authorities mentioned in the Bibliography appended hereto.

TREMATODA OR FLUKES. The members of this group are small parasitic flatworms with unsegmented flattened or cylindrical unciliated bodies, usually having anterior mouth-openings, bifurcated intestine and without anal opening, which attach themselves to their host by the means of suckers or hooks, or both, and live upon their juices. The Trematoda are classed in three groups or sub-divisions, of which the *Heterocotylea* are for the most part ectoparasites and the *Aspidocotylea* and *Malacocotylea* for the most part endoparasites. The North American *Heterocotylea* consist of five families, the *Temnocephalidæ*; *Tristomidæ*, *Monocotylidæ*, *Polystomidæ* and *Gyrodactylidæ*; divided into 8 families and 52 genera, mostly parasitic on Vertebrates and principally in marine animals, but some species have freshwater fishes and amphibia as host, of which one genera, the *Gyrodactylidæ*, will be particularly mentioned.

GYRODACTYLIDÆ This family includes the genera *Gyrodactylus* and *Calcostoma*, the former having double or more numerous prehensile hooks, the latter a single horny structure at the margin of the caudal sucker.

GYRODACTYLUS. This parasite is found on the gills of freshwater fishes in numerous specific forms, almost each species supporting a different form, and sometimes two or more on the same gill. The most common species, *G. elegans*; Fig. 80; infests the gills of Cyprinidæ, especi-



FIG. 80. *Gyrodactylus elegans*.
A Trematod Parasite.
Greatly enlarged.

ally the carplike fishes, often in such numbers as to cause the death of both young and mature fishes, especially the very young. Other species which have freshwater fishes as hosts are *G. carassiusculus*, *G. cochlea* and *G. tenuis*. These parasites also attack the surface of fishes and amphibia and burrow into the skin under the scales, where they produce inflammations and raw surfaces which form seats for fungi and ultimately cause the death of the fishes. *Gyrodactylidae* are among the most frequent parasites which affect the goldfish in the aquarium and breeding tank.

The North American Aspidocotylea and Malacocotylea consist of *Paramphistomidae*, *Fasciolidae*, *Schistosomidae*, *Holostomidae*, *Gasterostomidae*, *Didymozaönidae* and *Monostomidae*; divided into 35 sub-families, 134 genera and 22 related genera, parasitic in Vertebrates, of which the following species are found in freshwater fishes and amphibia of the United States:—

SPECIES	HOST	PART INHABITED
<i>Distomum areolatum</i>	White Perch	in intestine
" <i>rufoviride</i>	Striped Bass	" "
" <i>seriale</i>	Salmon	" kidneys
" <i>tenuis</i>	Striped Bass	" intestine
" " <i>tenuissime</i>	White Perch	" peritoneum
" <i>auriculatum</i>	Lake Sturgeon	" intestine
" <i>grandiporum</i>	Eel	" stomach
" <i>gracile</i>	Sunfish, Goldfish	" liver and intestines
" <i>laureatum</i>	Sucker	" alimentary canal
" <i>polymorphum</i>	Pike	" bladder
<i>Diplostomum cuticola</i>	{ Red-eye Bass, Black Bass { and Goldfish	{ intestines, { liver and heart, <small>also gills and surface</small>
<i>Gasterostoma gracilescens</i>	Carp and other Cyprinidae	" intestines
<i>Octoplectanum affine</i>	Sun Fish	" gills
<i>Stephanochasmus tenuis</i>	Striped Bass, White Perch	" intestine
<i>Tristoma elongatus</i>	Sturgeon	" gills
<i>Monostomum spatulatum</i>	Carp { <small>and other Fresh-</small> water Fishes.	" intestines and liver
" <i>amuii</i>	Catfish	" bladder
<i>Cephalogonimus vesicaudus</i>	Softshell Turtle	" intestine
<i>Distomum cheydræ</i>	Snapping Turtle	" "
<i>Pleorchis mollis</i>	Mud Turtle	" lungs
<i>Telorchis angustus</i>	Painted Turtle	" intestine
<i>Amphistoma subclavatatum</i>	Frog and Tadpole	" "
<i>Brandesia areana</i>	"	" phyloris
<i>Distomum quietus</i>	"	" intestine
<i>Gorgoderia cygnoides</i>	"	" bladder
" <i>amplicara</i>	"	" "
" <i>simplex</i>	"	" mouth
<i>Halipegus ovocaudatus</i>	"	" liver
<i>Holostomum nudus</i>	"	" intestine
<i>Ostioleum formosum</i>	"	" "
<i>Cymotocarpus hospitalis</i>	" " "	" "
<i>Distomum quietus</i>	Salamander	" bladder
" <i>ascoidum</i>	Snails	" intestines, etc.
" <i>coronarium</i>	" Molluscs, Alligator	" " "



FIG. 81. *Distanum gracile*, a Trematod parasite. Greatly enlarged.



FIG. 82. *Diplostomum cucullata*, a Trematod parasite. Greatly enlarged.



FIG. 83. *Gasterostoma gracilescens*, a Trematod parasite. Greatly enlarged.

CESTODA OR TAPEWORMS. This group comprises the Tapeworms and other cystic Entozoa which are parasitic during the greater part of their lives; with some species the eggs only are free during certain periods to change their residence. The Cestoda are taken as one group or sub-order, the *Pseudophyllidae*, which consists of five families, the *Bothriocephalidae*, *Tetraphyllidae*, *Cyclophyllidae*, *Diphyllidae*, and *Trypanorhyncha*; divided into 16 sub-families, 72 genera and 28 related genera, parasitic on Vertebrates, of which the following species are found in freshwater fishes and amphibia of the United States:—

SPECIES	HOST	PART INHABITED
<i>Bothriocephalis proboscideus</i>	Carp and other Cyprinidæ	in phylorus and intestines
“ <i>nodosus</i>	Stickleback	“ alimentary canal
<i>Cyathocephalus truncatus</i>	Whitefish	“ phylorus
<i>Dibothrium hastatum</i>	Sturgeon	“ intestine
“ <i>cordiceps</i>	Trout	“ “
“ <i>infundibuliforme</i>	Burbot and Whitefish	“ “
<i>Dacnitus globosa</i>	Trout	“ body cavity
<i>Ligula simplicissima</i>	Carp and Tench	“ “ “
“ <i>catostomi</i>	Sucker and Chub	“ intestine, etc.
<i>Monobothrium hexacotyle</i>	Sucker	“ “
“ <i>terebrans</i>	“ and Chub	“ “
<i>Schistocephalus dimorphus</i>	Sculpin, etc.	“ abdominal cavity
“ <i>solidus</i>	Stickleback and Cyprinidæ	“ “ “ and muscular tissues
<i>Tenia saxelini</i>	Whitefish	“ intestine
“ <i>ocellata</i>	Rock Bass	“ “
“ <i>dilatata</i>	Eel	“ “
<i>Triculpidaria nodulus</i>	Bass, Perch and Pike	“ “



FIG. 84. *Bothriocephalis proboscideus*, a Cestod parasite. Twice natural size.



FIG. 85. *Ligula simplicissima*, a Cestod parasite. Natural size of immature form, the adult is parasitic in Mammals.



FIG. 86. *Schistocephalus solidus*, a Cestod parasite. Immature form, 6 to 15 mm. long, the adult is parasitic in Aquatic Birds.

Probably the most frequent forms of Cestode parasites are *Schistocephalus solidus* and allied species, which occur in many freshwater fishes in

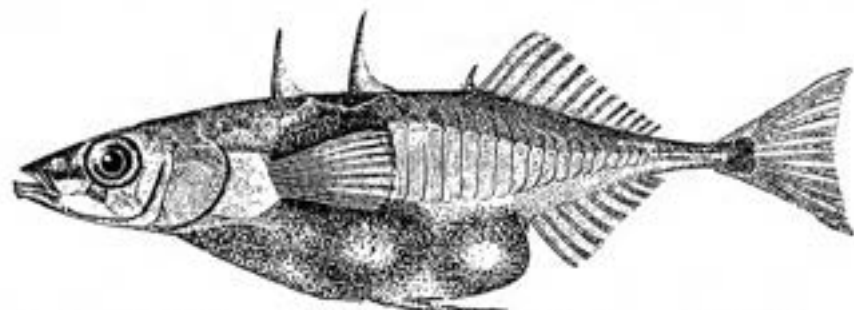


FIG. 87 Stickleback affected with *Schistocephalus solidus*; showing enlargement of side and abdomen. Slightly enlarged.

immature forms. Figs. 86, 87 and 88. As adults they have fish-feeding birds and mammals as hosts.

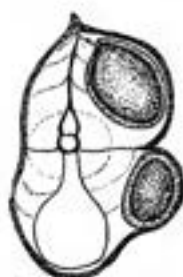


FIG. 88. Section of a Stickleback, showing cysts of *Schistocephalus solidus*. Slightly enlarged.

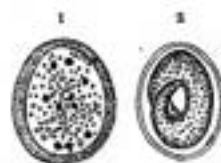


FIG. 89 *Ascaris acus*, a Nematode parasite. 1. Immature forms, enlarged. 2. Subsequent adult form, enlarged.

NEMATODA OR ROUNDWORMS. This group comprises the round and thread worms. They include a large number of families which occur abundantly in all genera of the Vertebrates and are more numerous and uniformly distributed than the individual members of the other parasitic orders. They have not apparently had the attention of Helminthologists that has been given to many other groups and the literature is fragmentary and widely scattered. Mention will here be made of the six principal families and the more generally distributed species.

ASCARIDÆ AND CHEIRICANTHIDÆ. These parasites inhabit higher Vertebrates, principally birds and mammals, but two Nematods, bearing close resemblance to *Ascaris teniusissima*, have been found in Western trout. *Ascaris acus* in the adult form is encysted in the intestines of pike, bass and trout, Fig. 89. Its immature existence is spent in the minnow, dace and other Cyprinidæ and with them is introduced into the subsequent host.

CUCULLANIDÆ. Several species of these parasites occur in freshwater

fishes. These are *Cucullanus foveolatus* of the sunfish, and *C. elegans* of the perch and the Cyprinidæ, Fig. 90.



FIG. 90.
Cucullanus elegans,
a Nematod parasite.
Length of female 15
mm., male 8 mm.

FILARIDÆ. These parasites are more common to the marine fauna. *Filaria piscius* is found spirally coiled within the tissues of the herring, cod and whiting. A number of other species of this family occur in similar hosts and in warm-blooded animals.

GORDIIDÆ. These parasites take up a free existence in damp earth and penetrate the bodies of insects and their larvæ. Some gain access to fishes by this means, where they become encysted in the tissues.

ANGUILLULIDÆ. These minute free intestinal thread-worms usually have the higher Vertebrates as hosts, but some species are parasitic in aquatic molluscs and in insect larvæ. They are very widely distributed; the so-called Vinegar-eel, *Anguillus aceti*, belongs to this order. All the other families of this group are parasites of higher Vertebrates.

ACANTHOCEPHALA OR THORN-HEADED WORMS. This group consists of members having vermiform bodies and otherwise resemble the Nematoda, but differ in having spine-covered heads by which they attach themselves to their hosts. They are now included in the single family Echinorhynchidæ, which infests all classes of Vertebrates and are one of the more frequent parasites of fishes and amphibia. Over 100 species have been described, a considerable number in the Cyprinidæ; and of these *Echinorhynchus proteus* is the most abundant species, of which the immature form inhabits the smaller crustaceans, especially *Gammarus* and *Asellus*, to be transferred with them to freshwater fishes. Other



FIG. 91.
Echinorhynchus proteus, an Acanthocephalous parasite. Intermediate and Adult forms. Greatly enlarged.



FIG. 92.
Echinorhynchus angustatus, an Acanthocephalous parasite. Length 22 to 25 mm. Enlarged.



Fig. 93.
Echinorhynchus anthuris, an Anthocephalous parasite. Greatly enlarged.

common forms are *E. angustatus*, *E. claviceps*, *E. anthuris*, *E. globulosus*, and *E. tuberosus* in the Salmonidæ and similar fishes. Some of these and *E. clavula*, *E. fusiformis* and *E. pachysoma* frequently occur in other freshwater fishes, principally the Cyprinidæ. *E. anthuris* also occurs in the Water newt, and *E. inflexus* in the Snapping turtle. The Echinorhynchidæ cause

epidemics in fishes and in immature and adult forms have been found in such numbers in the gills of young goldfishes as to cause the death of entire hatchings. These worms grow to such size that they force the operculæ from the sides of the head and produce death from exhaustion and inability of the fishes to breathe. No preventive means or parasiticides have been devised to eradicate these destructive parasites, most of the species of which do not exceed 1 cm. in length, and many of them are much smaller.

HIRUDINIDÆ OR LEECHES. These parasites are divided into two groups, the *Rhynchobdellidæ* which pierce the tissues of their hosts by means of a fine protrusile stomodæum or proboscis, and the *Gnathobdellidæ*

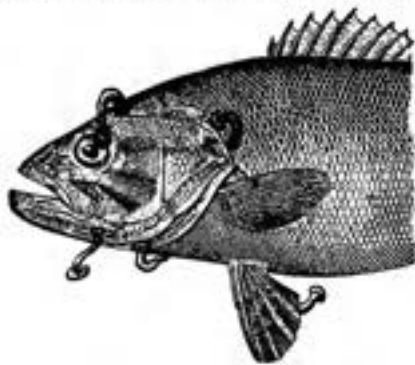


FIG. 94. *Piscicola funduli*, the Carp-leech, attached to the head of a young Small-mouthed Black Bass. Slightly enlarged.

which bite their prey by means of triangular horny jaws. They are carnivorous oblong and generally depressed contractile worms, having the mouth encircled with a lip and a flat disc at the posterior end, both adopted to adhere to other bodies and to serve as organs of locomotion. Leeches abound in both fresh and salt water and in tropical countries some forms live on the land secreted among leaves. Fishes, frogs and turtles are most frequently

attacked, but they also attach themselves to other animals which come to the water to drink. The larger blood-sucking forms are *Hirudo* and *Macrobdella*; and the true parasitic forms belong to *Ichthyobdella*, *Cystobranchus* and *Clepsine* which feed principally on fishes, and *Nephelis* and *Aulastomus* on snails and worms. The North American leeches which prey on freshwater fishes and amphibia are the species *Piscicola funduli*, known as the Carp-leech, Figs. 94 and 95, *P. punctata*, *Actinobdella inequiannulata*, *Philobdella gracile*, *Clepsine elegans*, and *C. parasitica*. Young leeches infest the gills of fishes, especially the fry, literally packing them solid, and gorge themselves with the blood, causing the death of their hosts. These epidemics sometimes occur with broods of goldfishes. The only remedy is to clean the tanks and destroy the aquatic plants. Cures of leech infested fishes have been made by the brackish water treatment and by injecting salt water into the gills.

A very minute leech-like polyp *Trichodina pediculus*, Fig. 96, is usually parasitic on freshwater polyps but frequently changes to fishes as



FIG. 95. *Piscicola funduli* Enlarged 4 diameters



FIG. 96
Trichodina pedicularis
a Hirudinid parasite.
Greatly enlarged.

its host; and produces tiny red external, gill and throat ulcers into which it is pitted like a cancer. When present in numbers it is a dangerous parasite and has been found on fishes afflicted with what is popularly known as Twitters. It has a nearly circular ciliated body and on its lower side a sucktoral disc.

ARACHNIA OR ARACHNID PARASITES. This group includes the Mites, Ticks, etc., of which some of the aquatic species are discussed in the appendix to the Aquatic Insects. One family, *Trachearia*, contains strictly parasitic genera, and the *Acharidae* and *Hydrachnidae* have parasitic and predatory members which subsist largely on the freshwater fauna. The common form is the red Water-mite, *Hydrachna geographica*, Fig. 97. With five other families of this group parasitism is but slight and on the higher Vertebrates.



FIG. 97. *Hydrachna geographica*, an Arachnid parasite. Enlarged.

CRUSTACEA OR CRUSTACEAN PARASITES. This group includes the so-called Fish Lice, small crustaceans known as Epizoa, and belonging to the families *Lernææ*, *Caligidæ* and *Argulidæ*.

LERNÆDÆ AND CALIGIDÆ. The members of these families rarely occur as parasites on the freshwater fauna, having those of saltwater as hosts; but some are brought into freshwater by marine fishes in their



FIG. 98. *Lernæca cyprinacea*, a Crustacean parasite. Adult and free-swimming larva. Enlarged.

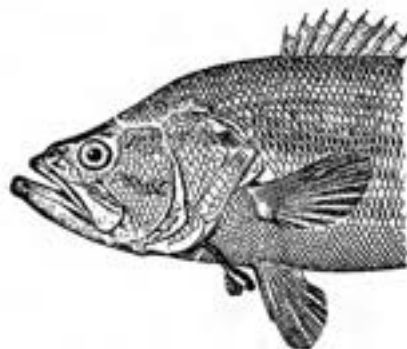


FIG. 99. *Lernæca cyprinacea*, attached to the gill of a young Large-mouthed Black Bass. Slightly enlarged.

spawning migrations. One form, *Lernæca cyprinacea*, Figs 98 and 99, occurs in freshwater and is a frequent parasite on fishes. It attaches itself by peculiar sucker-tentacles to the gills, fins and surface, and is a very frequent parasite on river and pond fishes, of such size as to be easily seen.

ARGULIDÆ. These Copopods are known as Carp-lice, though they have almost all the freshwater fishes and amphibia as hosts. Of the three genera *Argulus*, *Chonopeltis* and *Dolops*, 42 species have been recognized,

mostly of the first-named genus; of which some are marine and others freshwater forms. Those on migratory fishes are able to change with their hosts from salt to freshwater and the reverse. They are wholly external parasites, either in the gills or on the surface, and frequently change their host, though each species prefers a certain genus or closely related kinds, to which it is usually confined. They have a flat rounded carapace, notched on either side and bluntly projecting in the centre, nearly transparent, and elegantly marked in colors; smooth above and armed below with spines to attach themselves on the surface of their hosts, to which they also cling by anterior maxillipeds which are modified into sucking discs, and by clasping posterior legs or maxillipeds. They can swim freely and the males frequently abandon their hosts in the breeding season, as do also the larger females, at times, as unlike other copopods, the hundreds of eggs are not carried in sacs but are fastened in rows on objects on the bottom. As their food is the blood of their host, extracted through the sucking discs, they are destructive parasites which become serious



FIG. 100. *Argulus catostomi*, a Crustacean parasite. Enlarged ventral and dorsal views, and natural size.

menaces, especially in the confines of the aquarium, where they are prevented from changing to a number of fishes. They are of frequent occurrence on both pond-raised and imported goldfishes, usually easy of detection by their size and shape.

The general American freshwater form is *Argulus catostomi*, Fig. 100. Other common Crustacean parasites on the gills and surface of freshwater fishes are *Achtheres lacei*, *A. percarum*, *Ergasilus funduli*, *Lernæopoda fontinalis*, *L. siscowet*, *L. coregoni*, *L. pomotidis*, *Lamproglena pulchella*; and *Lepeophtheirus salmonis* on Salmon in freshwater.

INSECTA OR INSECT PARASITES. This group includes the Lice, Fleas, and other insect tormentors. As they do not affect fishes and amphibia they will not be further mentioned, though many of the aquatic insects and their larvæ could be included in this group. They are elsewhere mentioned and described.

PROTOZOA OR PROTOZOAN PARASITES. This group embraces the lowest forms of the animal kingdom; organisms possessing but a single cell or colonies of unicellular beings. They are divided into 4 sections, 4 classes and 21 orders, many of the 38 genera of which are for the most part entozoal, but some are ectozoal parasites. The sections of interest to the fish-culturist are the *Bacteridæ*, *Sporozoa* and *Infusoria*.

BACTERIDÆ. This section of the Protozoa includes orders which are both saprophytic and parasitic, potent factors in the causation of

diseases of fishes. They have not received much attention from Bacteriologists and but few have been identified.

Lymphosporidium truttae produces a disease in aquaria and among domesticated fishes not yet observed in wild ones from natural waters. The bacteria, Fig. 101, are short rodlike micrococci which grow out into filaments, and infest the gills, blood, muscles, skin and surface generally. This micrococcus is usually present in cases of Autotoxine of aquarium fishes. Healthy fishes succumb

to the bacteria in a few days when inoculated beneath the skin and after a longer time by mixing cultures with their food. It is to be hoped that future investigations will familiarize the fish-culturist with many other of these bacterial causes of fish diseases, and with methods for their destruction.

SPOROZOA. This section of the Protozoa includes orders which contain many parasitic genera. The orders of the *Cytoporidae* are the *Gregarinida*, *Coccidiida*, *Hæmosporidiida* and *Gymnosporidiida*. The orders of *Myxosporidia* are the *Phenocystida* and *Microsporidiida*; and in addition to these are the orders *Sarcosporidia*, *Amæbosporidia* and *Serumsporidia*.

GREGARINIDA. Of this order none of the genera have been found as parasites on freshwater fishes or amphibia.

COCCIDIIDA. The freshwater parasites of this order belong to the genera *Rhabdospora* and *Coccidium*. *R. thêlohani* have been found in the intestines of the perch, the ovarian tissues of the pike-perch, and in the liver of the stickleback; *C. metshinkovi* in the intestines of the goby; and *C. gasterostei* in the liver of the stickleback. None have been found on the Cyprinidæ.

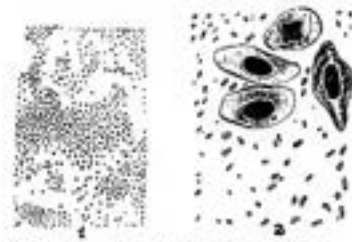


FIG. 101. *Lymphosporidium truttae*, a Bacterial parasite. 1. Enlargement. 2. Greatly enlarged Blood corpuscles and Bacteria.



FIG. 102. *Myxobolus sp. incert.*, a Sporozoon parasite of the Goldfish and other Cyprinidæ. Greatly enlarged. 1. Cyst in cuticle and tissues. 2. Cyst containing vacuoles. 3. Ruptured cyst and escaping vacuoles.



FIG. 102A. Head and shoulder of a Goldfish affected with *Myxobolus sp. incert.*

MYXOSPORIDIA. The freshwater fish-parasites of this order belong to the genera *Myxidium*, *Myxobolus*, *Henneguya*, *Nosema* and *Plistopora*.

MYXOSPORIDÆ. These Protozoa, Figs. 102, 102A, 103, 104 and 104A, are entirely parasitic and in the majority of cases live upon fishes. Dr. R. R. Gurly listed 102 hosts, fishes and other aquatic fauna, inhabited by them, either encysted beneath the skin, on the surface of the head and fins, or in the gills, mouth, eyes, gullet, air bladder, heart, liver, spleen, stomach, intestines and almost every other part of the body. The effect of their presence is a breaking up of the parts, which undergo a vitreous degeneration, the growth of tumors and postules and ultimately the death of the host.



FIG. 103. *Myxobolus cyprini*, a Sporozoan parasite, encysted in the Kidneys of a Carp. 1. Enlarged 2. Natural size of cysts.

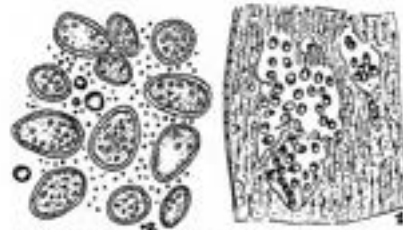


FIG. 104. *Myxobolus ellipsoides*, a Sporozoan parasite. Greatly enlarged.
1. Cyst in the tissues of the Air-bladder of a Tench.
2. Psorespores liberated from the cyst, highly magnified.

They are usually amœba-like microscopic organisms, which reproduce within or without the cyst or tissue cavity with those species which inhabit the surface; and constantly within the cyst with those which inhabit the cavities of the hollow organs of their hosts. Mention will only be made of those Myxosporidæ of the orders *Phænocystida* and *Microsporidiida* common to



FIG. 104A. Dermal cysts of *Myxosporidium genus incert*, a Sporozoan parasite, on the skin of a Minnow. 2. Liberated psorespores, highly magnified.

freshwater fishes, batracians and larger crustaceans, the table showing how many species have been identified and the parts they inhabit. It is seldom that they have more than one particular host; that of the goldfish, for instance, being *Myxobolus sp. incert*, Figs. 102 and 102A, and Table p. 156.

Myxosporidæ spare no organ or elemental cell and nearly all of them produce a cachexia, comparable with the cancerous tumors of warm-blooded animals. They are the cause of violent epidemics among fishes and have occasioned the deaths of hundreds of tons of food fishes in a very short time when outbreaks of the contagious diseases caused by them have

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occurred. They are present in all bodies of water and a careful observation of catches of freshwater fishes will almost always reveal some affected with the postules or tumors produced by these protozoan parasites.

Number of species observed	Host	In Body cavity	Encysted in gills	Encysted in Subcutaneous tissue	On fins	In Vitreous humor of eye	Encysted in spleen or liver	Encysted on head	Encysted in Muscular fibre	Encysted in ovary and renal tubes	Encysted in gall bladder	Encysted in air-bladder and intestines	Surface tumors	Throughout most interior organs
1	Goldfish	x				x								
7	Carp		x	xx	x			x						
6	Tench		x	xx		x						x	x	
5	Sunfish	x	xx						x					
4	Stickleback			xx						xx				
4	Minnow		x	x									xx	
3	Perch	x		xx										
4	Pike-perch		xx	x				x						
2	Pike		x			x								
4	Chub-sucker	x	x						x					x
1	Mullet		x											
2	Gudgeon	x												x
1	Barbel												x	
1	Eel										x			
2	Catfish			xx										
2	Frog						x						x	
2	Toad										x			x
1	Crayfish								x					
1	Prawn								x					
1	Shrimp								x					

INFUSORIA. This section of the Protozoa includes orders which contain many parasitic genera. The countless host of Infusoria is divided into 3 classes, 13 orders and 306 genera; of which 286 recognized species occur in rivers and other freshwater, 76 species in pond water, 15 in marsh water, 4 in ditch water, 13 in bogs, 17 in standing and stagnant water, and 1 in spring water; while 80 species occur on or among aquatic plants, 35 in and on entomostraca, 16 in and on frogs, toads and salamanders, 14 in molluscs, 5 in and on polyps and sponges, 4 in earthworms and tubifex, 18 in aquatic insects, and 4 are parasitic in and on fishes. These are the following:—

ICHTHYOPHTHIRIIDÆ. These infusoria are probably the most frequent and general forms of freshwater fish parasites. Small raised white spots develop on the skin, which increase to larger blotches, spread over the sides, head and fins, until the fish assumes the appearance of being dotted with white and covered with slime. These extend to the mouth and œsophagus and enter the gills, when the fish wastes away from loss of appetite, difficulty

in breathing and the sloughing away of the skin. The following are the recognized most common freshwater species likely to be encountered by the aquarist.

ICHTHYOPHTHIRIUS MULTIFILIIS. This infusorian, Figs. 105 and 106, first forms round milky spots on the skin, fins, eyes and gills of freshwater fishes. A microscope examination will reveal that each spot is caused by



FIG. 105. *Ichthyophthirius multifiliis*, an Infusorian parasite. Greatly enlarged.
 1. Ciliated spore.
 2. Segmentation upon encystment.
 3. Adult infusorian.

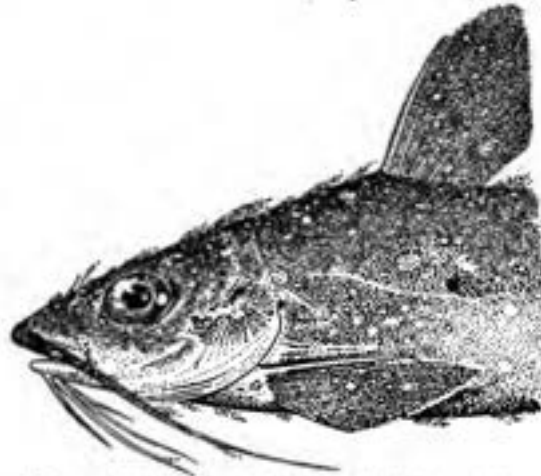


FIG. 106. Head of a Catfish affected with *Ichthyophthirius multifiliis*.

the presence of a ciliated infusorian, the epidermis of the fish forming a considerable protuberance over the parasite. Sometimes two or three infusoria inhabit the same cyst, the form of the younger differing from that of the grown individuals. The fishes soon appear completely emaciated, the skin becomes thickened where the parasite is encysted, a scum forms on the surface and deaths occur in ten days to two weeks.

PANTOTRICHUM LAGENULA (*U. lagenula*.) This infusorian, Fig. 107, is parasitic on the skin and in the gills of freshwater fishes and produces the "Spot-disease" or "Pox," by living in the pulp cavity of the scales and absorbing their contents, pigment cells, etc., producing colorless patches on the skin. These spots first appear as slimy excrescences, later assume a funguslike appearance, and finally cause the death of the fish by emaciation and destruction of the tissues.



FIG. 107. *Pantotrichum lagenula*, (*Urstricha lagenula*), an Infusorian parasite. Greatly enlarged.
 Dorsal and lateral views.

The infusorian has an oval body with a sucking disc and swimming appendage, and the cuticle is covered with very fine evenly-developed cilia.

TRACHELOCERCIDÆ. Of these infusoria the most frequently occurring freshwater species, is the ciliate *Holotricha*, *H. mystacca*, Fig. 108, a more or less elongated or flask-shaped infusorian, entirely covered with cilia; with delicate flexible cuticle and the anterior part of the body at times

extended like a proboscis. It is most frequently observed on fishes kept under unsanitary conditions or which have become exhausted from fright, transshipment or other disturbing causes.

The following are nearly related forms.

CHROMATOPHAGUS PARASITICUS. On the bodies of freshwater fishes, very distinct milky-white spots develop, caused by these large infusoria lodging on, or in, the epidermis, which show a distinct rotating motion between

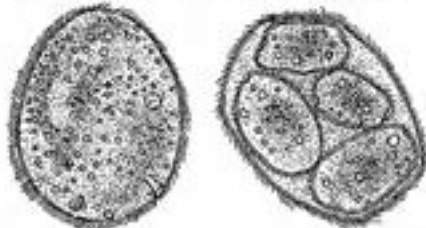


FIG. 109. *Chromatophagus parasiticus*, an Infusorian parasite. Greatly enlarged.

the epidermic cells, Fig 109. These parasites are usually single, but sometimes two or three are imbedded close together. Their shape is variable but most often oval with the longer diameter 0.615 mm. and the shorter 0.408 mm. The body is enclosed in a thin elastic cuticle covered with fine cilia, the layer

below finely granular, filled with a large number of contractile vacuoles of different size. They have a proboscis-like sucking tube. The presence of these parasites is manifested by the formation of cysts on the surface of the fishes, which enlarge until the skin and head are covered by funguslike postules in which the boring infusoria are encysted. Death results from exhaustion and the ravages produced by the parasites. A similar infusorian has been found in the blinded eye of a Telescope goldfish.

TETROMITUS NITSCHERI. This infusorian, Fig. 110, previously recognized as *Contia necatrix*, is supposed to have only the Japanese Fringetail goldfish as host, but a very similar species, *Bodo necator*, is very destructive to young trout in Europe, and the described form is probably a Japanese species of the same genus. This minute organism attaches itself to the surface and under the scales in vast numbers, often hundreds in a space as large as the head of a pin. Its presence is manifested by excessive mucous coating, red spots and ulcers. In the free-swimming stage it has a flattened appearance with cilia at one side by means of which it moves through the water until it comes in contact with its future host. When not checked this parasite may become so numerous as to cause the destruction of all the fishes in an aquarium.

None of the other mentioned orders of Infusoria are parasitic on fishes but a considerable number occur with other lower forms of aquatic fauna.



FIG. 108. *Helarichthys mystacea*, an Infusorian parasite. Greatly enlarged.



FIG. 110. *Tetromitus nitscheri*, (*Contia necatrix*) an Infusorian parasite. Greatly enlarged.

ROTIFERA OR PARASITIC ROTIFERS. Three genera of Rotifera, *Albertia*, *Balatro* and *Dictyophora* are parasitic on the freshwater fauna. Some of the already described forms must not be mistaken for this group, whose occurrence on the Cyprinidæ is not common. Many parasites are designated as "Rotifers" by the fish-culturists, but belong to much lower orders, or are larval forms differing in appearance from the adults.

PREVENTION OF PARASITIC DISEASES. The best preventive measures against parasites in the aquarium are care in not introducing them upon fishes and plants and guarding against their spreading by constant vigilance. A careful examination of every newly acquired fish should be made; the appearance of the surface and gills, the condition of the fins and the manner in which they are carried, the behavior of the fish and its general condition noted. Newly acquired fishes should be quarantined at least a week and aquatic plants inspected and carefully cleaned before either are put into the aquarium. A microscope examination of anything suspicious is also advisable. Infected fishes should be placed in the most salubrious surroundings, with a plentiful plant growth, abundant aeration, and nutritive food given.

An already mentioned sometimes effective remedy is to place the affected fishes, or any subjected to contagion, in water taken from neglected out-of-doors tanks which has become very green with algæ and other low forms of plant and animal life. This is worth a trial as beneficial results often follow; but if the afflicted fishes are not of value, and their disease does not yield to the remedies before and hereafter mentioned, their destruction is advised. The most rigorous sanitary regulations are required in the infected aquaria or tanks, to destroy every trace of parasites.

PARASITICIDES. An absolute means of destroying fish parasites has not yet been found, though acid and alkaline substances have proven beneficial and have effected cures. They destroy the free-swimming parasites but have not been as successful with those burrowing in the skin or in the gills. Solutions which would destroy these are oftentimes fatal to the fishes prior to exterminating the parasites. German ichthyological authorities recommend the following remedies, all of which require close attention in their application:

Two grams of salicylate of soda are to be dissolved in one litre of warm water and permitted to cool. Two vessels, holding about three gallons each, are required; one filled with well-aerated water, of the same temperature as that to which the fish has been accustomed, the other containing $1\frac{1}{2}$ gallons of the same water. These should be prepared early in the morning and the fish introduced into the partly filled one, after which small even quantities of the solution are to be added at frequent

intervals until by evening all has been introduced. After about two-thirds of the solution has been added, careful attention must be given to the fish, and if its condition is weak and the indications are that it would be endangered by a stronger bath, it should be removed to the second vessel, the water of which has been aerated by frequently dipping out and pouring back. It is necessary to leave the fish in the solution as long as endurable without complete exhaustion indicated by excessive restlessness and later by partly or completely turning on its side. Should the fish not recover at once in the second vessel, it must be kept in motion by gently stirring the water.

Picric acid has also been found to be beneficial. A one-percent. solution of this poisonous acid is made in hot water. The fish is placed in well-aerated water to which small quantities of the solution are added, until ~~1/1000~~ to ~~1/1000~~ part of the acid is present in the water, if the fish can endure this amount, and then, after a few minutes, water of the same temperature is added at intervals until a very considerable dilution has taken place, when the fish should be removed to well-aerated water. This may be repeated after a few days, the fish to remain in the weakened bath several hours, if possible. Chlorate of potassium is used in the same manner, but the amount present in the water should not exceed 1 in 1000. All three of these remedies are certain to destroy the higher forms of surface parasites, and usually those encysted on the fish.

American breeders have successfully applied the following remedies, all of which are to be recommended:—

Permanganate of potassium solutions are powerful disinfectants and frequently used specifics, but are not always efficient. They produce an objectionable discoloration of the water and when sufficiently strong to destroy the parasites cannot be endured by the fishes. The best application is by the use of a separate vessel, and covering the mouth and gills of the fish with a wet cloth agitating the body in a strong solution for a few minutes, then placing the fish into water to wash off the potassium before returning it to the hospital jar.

Bichloride of mercury has been found to be beneficial when applied in the same manner, also a weak solution of formalin; a tablet of the former in a pint of water and a 10 percent. solution of the latter. Salt is a generally applied and safe remedy, and should be used as previously mentioned, a strong solution kept from the gills, and a weaker one by placing the fish into it for one or more days.

External applications of boracic acid in water have proven effectual for surface parasites, and should be frequently applied with a brush or a pledget of cotton. Very satisfactory results have been obtained with a 50 percent. solution of peroxide of hydrogen in water. The fish is grasped

by the head, to close the operculæ and mouth, and the rest of the body immersed for five seconds, the treatment to be repeated at intervals of one day. All newly acquired fishes should be so treated before introduction into an established aquarium. No ill results follow and salutary effects are certain.

A recent highly recommended remedy is the *ANTIGYRODACTYLIN*,* of Paul Nitsche, for the extirpation of surface parasites on fishes, especially those of the aquarium. The fishes should be well fed about two hours before treatment and receive no food three hours thereafter. The treatment is to be applied three succeeding days. The fish is to be taken by the head and gently passed backward and forward through the Antigyrodactylin for $1\frac{1}{2}$ to $1\frac{3}{4}$ minutes, not longer. Then it should be placed in a vessel containing well-aerated water, that the parasites may drop off and sink to the bottom. After five minutes it should be transferred to a second similar vessel, and then, after expiration of another five minutes, to a third large shallow-water vessel containing just sufficient water to enable the fish to swim. This water should be changed daily and the vessel scoured. It is advisable to have the water of each vessel one or two degrees colder than the preceding, on account of its effect on the parasites, as it will aid in their leaving the fish.

If the fishes show indications of exhaustion after the bath, they should be kept in motion for some time with a light wooden rod.

A litre of Antigyrodactylin is sufficient for the treatment of twenty fishes. Taken internally it is poisonous, but is harmless externally, even on wounds and abrasions.

VEGETAL PARASITES AND PARASITIC DISEASES. All animal and vegetable substances are subject to the attack of low forms of vegetal parasites, and though they are not all necessarily malignant, many of the diseases of aquatic animals and plants are directly due to the presence of these micro-organisms, which are saprophytic upon the dead and parasitic upon the living tissue.

The vegetal parasites found on animal bodies belong to the class of Cryptogamia and the orders Algæ and Fungi; distinguished from each other by the presence of chlorophyll or other coloring substances in the former and their absence in the latter.

PARASITIC ALGÆ. The aquatic forms of this order, or those which have preserved some essential algal features, found on animals, consist of single or branching, cylindrical or flattened filaments, which have no method of fixing themselves but are firmly held by the crossing of their fibres. The reproductive system consists of round or oval spores enclosed in a case or

*To be obtained of H. Lehmann & Co., Chemists, Berlin.

sporangium. They subsist on the juices of their host. Other forms are parasitic upon either growing or dead and decaying plants.

PARASITIC FUNGI. The aquatic forms of this order, the Phycomycetes, found on animals and plants, consist of densely interwoven masses of cellular filaments, which terminate in or constitute the rootlike mycelium, from which hyphæ and spore capsules are developed. With some species there is but a single hypha with reproductive bodies at the ends, this being the case with the more ordinary forms which affect the freshwater fauna. As fungi contain no chlorophyll they must take up and assimilate nutritive substances from other organisms and are therefore either saprophytic or parasitic.

The Phycomycetes are separated into five groups or sub-orders: 1, the *Clytridiaceæ*, of which a considerable number of species are parasitic upon Protozoa, Anguillulæ, Rotifera, Algæ and Saprolegnia; 2, the *Ancylistaceæ*, parasitic upon Conjugatæ, Chlorophyceæ and Anguillulæ; 3, the *Monoblepharidaceæ*, nearly all saprophytes; 4, the *Peronosporaceæ*, of which one genus, *Pythium*, has species parasitic on water plants and saprophytic on organic substances; and 5, the *Saprolegniaceæ*, the order of greatest interest to the fish-culturist, as of all the above, this group and the *Peronosporaceæ* are, to greater or lesser degree, aquatic at some or all stages of their existence. Most of the *Peronosporaceæ* are aquatic only at certain stages and afterwards become land forms, but the *Saprolegniaceæ* are aquatic at all stages.

SAPROLEGNIAEÆ. This group of water molds contain both fresh and saltwater forms, of which the genus *Saprolegnia* is widely disseminated in all bodies of freshwater. The most generally distributed genera are *Saprolegnia*, *Pythiopsis*, *Dichtyuchus*, *Achlya*, *Aphanomyces*, *Leptomitus* and *Apodachlya*, present as saprophytes on dead and decaying aquatic animals and vegetal substances, and as parasites on all aquatic fauna, including the spawn and young and mature fishes, whenever the conditions favor their active development. This occurs on skin abrasions, bruises, wounds, loss of a scale, or on a torn or congested fin. When fishes are enfeebled and the mucus coating affected, when they are kept under unsanitary conditions or in too cold water, these fungi may develop to cover the entire body, first as a film and later as white or colored blotches on the head and body, in the mouth and gills, on the fins and on and under the scales, which they often force out of place; as, when once established upon and into the living tissue, they ultimately cause its destruction. Investigators have determined that the *Saprolegniaceæ* on fishes can be communicated to dead insects and those growing on dead insects and other low forms of aquatic fauna are communicated in their turn to living and healthy fishes.

The Saprolegniaceæ have the merit of scavengers in consuming the organic compounds of dead animal matter and when this source of nutrition is exhausted it is usually followed by a disappearance of the fungi; but under favorable conditions some species of this genus become active parasites on fishes, amphibia, insects and plants, and have caused epidemics of diseases in rivers and lakes, as well as among fishes in the confines of the aquarium and breeding tank.

SAPROLEGNIA. Fig. 111. The most common species of this genus is *Saprolegnia ferax* a minute vegetative body without stem or leaf, which may exist as a saprophyte and develop its spores. These drift



FIG. 111. Saprolegniaceæ, the most common Vegetal parasites of Freshwater. Greatly enlarged.
 43 to 45. *Saprolegnia ferax*,
 46 to 49. *Saprolegnia torulosa*.
 50. *Achlya apiculata*.
 51. *Achlya americana*.
 1 to 4. Hyphæ with spores.
 52. *Dicthyuchus polysporus*.
 53. *Lepidometes lacinus*.
 54. *Aphanomyces lewisii*.
 a to c. Budding spores.

about in the water, to immediately undergo a change in contact with a fitting animal surface not protected from their ravages. A rootlike nucleus or rhizoid is formed from which threadlike hyphæ grow, each bearing a Sporangium or brood-sac filled with spores, and forming a white cottony felt over a malignant sore. These ulcers, if not checked, spread over the surface and sap the vitality of the victim until death ensues. This parasitic fungus is one of the commonest and most frequent causes of epidemics among fishes. Other more or less common species of the eastern section of the United States are *S. mixta*, *S. monoica*, *S. torulosa*, *S. declina*, *S. astrophora* and *S. trileaseana*. Spores of one or more forms of these saprophytes are always

present in all freshwater and are therewith introduced into the aquarium.

PYTHIOPSIS. The most common species of this genus is *Pythiopsis cymosa*, a minute vegetative body similar to the foregoing, but with more slender hyphæ; which occurs in stagnant water and is parasitic upon low forms of vegetal life and saprophytic on organic substances.

DICTYUCHUS. This fungus produces a skin disease on cold-blooded animals and lower forms of aquatic life. In appearance it resembles *Saprolegnia*, but the sporangia are more fusiform. The most common species are *Dicthyuchus polysporus* and *D. magnusii*; the former as frequently present as an animal parasite as *S. ferax*. Usually they are associated on the same host.

ACHYLA. This fungus is one of the most malignant of the Saprolegniaceæ. It attacks marine fishes during their freshwater spawning

migrations. The entire body becomes covered with white gnawing ulcers, the gills livid, the eyes coated and glazed, and the surface ulcerated so that the raw flesh may be seen. When the fungus reaches into the respiratory organs death results. This fungus may be recognized under the microscope by its stiff and bristly appearance. The most common species of this genus is *Achlya apiculata*, a minute vegetative body having short, stout and stiff hyphæ and abundant sporangia upon short branches. It occurs on dead leaves and similar substances in stillwater pools and ditches, in the slime of stagnant water and in rivers and other natural water courses. Other frequently occurring forms are *A. megosperma*, *A. americana*, *A. oblongata* and *A. racemosa*.

APHANOMYCES. This fungus is parasitic on the Algæ, principally on the species *Spirogyra* and *Zygnema*, also on some of the Mosses and other low forms of aquatic plant life. It consists of very slender and delicate hyphæ, forming a fine film over the plant, which it destroys. The sporangia usually have a prickly appearance. The more common species are *Aphanomyces levis*, *A. phycophilus* and *A. scaber*.

LEPTOMETUS. This fungus grows in water containing considerable organic impurities especially in that to which the waste of factories finds its way. It may be recognized by the many-branching form of the hyphæ. The more common species of this genus is *Leptometus lacteus* a minute felted vegetative body which covers the bottom of streams for considerable distances with a thick white layer. Some of the *Leptometæ* also occur abundantly in localities where the streams contain starchy refuse and much decaying vegetal matter. They also flourish on animal remains and slaughter house refuse in streams, on decaying algæ, and in the slime of stagnant water. There are no reported instances of their having become parasitic on fishes but always indicate stream pollution.

APODACHLYA. This fungus occurs most frequently upon dead animal matter in water and no certain conclusions have been reached of its becoming parasitic on living organisms. It has received some attention from investigators as it is considered to be the first instance of the occurrence of sexual organs in these low forms of plants. Three species have been established, *Apodachlya brachynema*, *A. pyriferæ* and *A. completa*. As they are harmless to fishes they need no further description here.

OTHER COMMON FORMS OF FUNGI. *Penicillium*, *Aspergillus* and *Mucor* are also saprophytes which live upon decaying organic matter and particularly flourish in water containing salts of ammonia. The common forms are *Penicillium glaucum*, *Eurotium aspergillus glaucus*, *Mucor mucedo*, *M. racemosus* and *M. circinelloides*.

The large group of Schizomycetes or Yeast fungi are not treated of here as they do not enter into the subject.

TREATMENT FOR VEGETAL PARASITES. Fishes affected with parasitic fungi may be successfully treated and cures effected. When given immediate attention, the spread of the fungi may be checked by salt baths or local application of strong brine, followed by the peroxide treatment; but when the ravages are not at once checked they produce fatal results. They sometimes produce epidemics which cause the deaths of thousands of food fishes and of entire broods of goldfishes. There is no radical fungicide which is invariably effective with the fungi. The remedies for animal parasites should be applied as usually, a microscope examination only can determine what form of parasite is present.

PREVENTION OF FUNGI IN AQUARIA. Filtration of the water is a radical prevention of the introduction of and the removal of Fungi in the aquarium; but the spores may be brought over into the filtered water by the fishes themselves or on aquatic plants, snails and tadpoles, when these are introduced in fungused condition, or together with live food taken from unsanitary localities. Cleanliness in every particular is the best preventive, together with a frequent careful inspection of both the fishes and the scavengers, and the isolation of any which may have a doubtful appearance. Prevention is always easier than a cure. Strong and healthy fishes are seldom attacked by vegetal parasites, but the disease is sometimes communicated from weakened or bruised fishes introduced into a previously sanitary and well-established aquarium.

ALGÆ MORE OR LESS PARASITIC. The common forms of Algæ which adhere to the aquarium, on the aquatic plants, or suspended in the water, belong to a number of genera. Those most frequently met with are the following:

CHLOROPHYLLACEÆ. In the clouded water of a stagnant aquarium two forms of *Chlorococcum*, one motile and the other at rest, were found by Dr. H. C. Wood; the younger forms green, the older ones darkish-brown in color. They were so numerous as to make the water opaque and stagnant.

Androgynia huntii, forms delicate bright-green fringes on the plants and glass of the aquarium.

Bulbochæta dumosa, forms small bushy growths on larger Algæ, Confevæ and other plants in the aquarium.

Tolypothrix distorta, forms microscopic bright-green tufts or balls adhering to plants in the aquarium and to the glass.

Mastigonema elongatum, forms blackish-green nodules about the size of a pin head on Brook-moss and Characææ.

Batrachosperms are small gelatinous masses of Algæ which attach themselves to plants and submerged wood.

Lemanea grow in masses and form a turf-like covering on stones in water often two inches long. Some of the forms of this genus are present in all freshwater.

Nostocs cæruleum, *N. depressum*, *N. sphericum* and *N. lobatus*, are Algæ which adhere to aquatic plants and form tiny dark-green, brown and blackish tufts.

Cylindrospermum minutus, forms filamentous light-green to rusty-brown intricately felted minute masses on aquatic plants.

Gloiostrichia incrustata, forms tiny clusters of light-green, straight and stiff filaments bearing round fronds the size of a mustard seed on water plants.

Rivularia cartilaginea, appear as sub-globose, stiff, deep brown or blackish threadlike filaments, having small semi-globose fronds or cells containing spores, and attach themselves to aquatic plants.

Scytonema immersus, and *S. nægelii*, form dark green mats on aquatic plants, and *S. dubium*, dark masses binding the leaves together.

Other Algæ which cause green water and scum on ponds and stagnant water are *Oscillaria*, *Hydrodictyon*, *Zygnomacia*, *Wolffia* and *Vaucheria*.

Diatoms and *Dismids* are also often present in great numbers. These serve as food for fishes, and are in part the first food of the alevin and fry, their silicious casings aiding in the development of the bones.

CONFERVÆ. The *Cladophora* are the larger members of this genus, two of which are common in Eastern waters. These are *Cl. fracta* and *Cl. brachystelecha*. They seldom occur in aquaria, but *Scenodesmus polymorphus*, develops in quiet pools and ditches in such numbers as to make the water clouded and very green. It consists of short and slender filaments with tiny threadlike branches.

Aquarium fanciers have been led into considering all minute water plants as Confervæ. They are a small group of the large family of Algæ, and mostly of larger size than those which occur in aquaria.

SLIME FUNGI. When the sides of breeding tanks do not become coated with algæ, two or three species of the *Myxogastres* or Slime Fungi are likely to form. These are injurious to the spawn and young fishes and should be removed.

PLANT FUNGI. A number of injurious fungi on the larger aquatic and semi-aquatic plants are likely to be encountered by the aquarist. The more general of these are:—

Rhizopus necans, affecting lilies introduced from Japan. It lives as a saprophyte in the soil and becomes a wound parasite, gaining access

through broken roots or abraded surfaces and rots the bulb. A white mycelium forms upon which black sporangia stand erect on the short hyphæ. It is very destructive when once introduced.

Sclerotinia plorifera. The white pond-lily and kindred species are subject to this fungus which forms orange-brown and yellow specks on the stems, leaves and buds, which spreads and causes an unsightly appearance. It also attacks the finer species of exotic and hybrid lilies and is often communicated to other aquatic plants.

TREATMENT. The affected plants should be submerged for half an hour in a 1 or 2 percent. solution of salicylic acid and afterwards thoroughly cleansed, and the affected spots painted with a 5 to 10 percent. salicylic acid solution. Badly diseased bulbs and plants should be at once destroyed by burning and the others cleaned and repotted.